UNIVERSITY *of* CALIFORNIA COOPERATIVE EXTENSION
MONTEREY COUNTY
AGRICULTURE & NATURAL RESOURCES

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January 21, 2019

Chairman Wolff
Central Coast Regional Water Board
895 Aerovista Pl., Suite 101
San Luis Obispo, CA 93401-7906

Re: Comments to Ag Order 4.0 Options Tables

Dear Chairman Wolff,

University of California, Cooperative Extension (UCCE) has participated in agricultural research and education on the Central Coast for more than 100 years. During the past 15 years UCCE has been evaluating management practices to improve nutrient and water use efficiency of vegetable and berry crops produced in Region 3. We conduct our studies in commercial fields as well as at research farms in collaboration with growers and industry organizations. Highlights of our research and demonstration projects include:

- Determining the nitrogen (N) requirement and N uptake rates of the major vegetable and berry commodities produced on the Central Coast.
- Demonstrating the nitrate quick test for evaluating mineral N status of soil and for guiding fertilizer N rates.
- Commercial field trials demonstrating the fertilizer value of nitrate in irrigation water.
- Developing tools to use weather-based irrigation scheduling for improving irrigation efficiency.
- Evaluating best management practices to minimize pesticide toxicity in agricultural run-off.

We would like to take the opportunity to comment on the Ag Order 4.0 options table. Before providing specific comments, we would like to offer an overall comment about the Ag Order 4.0:

Proposed regulations should encourage growers to invest in better management rather than burdening the industry with increased reporting requirements that are not helpful for improving farming practices. If reporting requirements become overly complicated and/or expensive, then growers will likely have less resources to improve the management of their farming operations.

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Monitoring and Reporting

Fertilizer N applied (A_{fert}) Although reported A_{fert} rates would ideally be equal or less than published seasonal N uptake values for crops produced in Region 3 (Hartz 2019, In press), in practice the appropriate A_{fert} to match crop N requirements can vary due to several factors including: 1) soil nitrate-N levels in the root zone; 2) nitrate in the irrigation water; and 3) mineralization of nitrogen from soil organic matter, prior crop residues, and organic amendments.

The combination of low soil temperatures and heavy winter rains can result in low nitrate concentrations in the root zone of a crop planted in the early spring. Prior crops can also deplete nitrate from the soil. Under these circumstances, growers may need to apply more N than the crop takes up to achieve commercial yield and quality standards. As will be discussed later, nitrogen in organic amendments and fertilizers must mineralize through biological processes to become available for crop uptake. Temperature and soil moisture can affect the rate that these organic sources of N release nitrate.

For the second or third crop of the season applied fertilizer N can may be closer to crop uptake (and in some cases less than crop uptake) if mineralization of prior crop residues and soil organic matter contributes significant amounts of nitrate in the root zone.

Therefore, because fertilizer requirements depend on many factors, consideration of appropriate A_{fert} values for commodities should be carefully discussed with knowledgeable individuals and researchers to agree on realistic values that can help growers maintain their production and profitability and safeguard groundwater resources.

Nitrogen applied from water (A_{irr}): Although accounting for the N applied from irrigation water maybe useful for estimating nitrate loading to the ground water basin, only a portion of the N in irrigation water has fertilizer value for a commercially produced crop. Nitrogen contained in water applied for pre-irrigation and crop establishment has little benefit to the crop because the N uptake rate is very low during this phase of the crop. For many vegetable crops N uptake rates remain low until about half-way through the crop cycle, after which N uptake increases significantly as the crop rapidly grows. During this rapid phase of growth, accounting for the N applied in the irrigation water can reduce fertilizer N (A_{fert}) needed to match the N uptake requirements of a crop. We have conducted multiple trials at the USDA-ARS research farm in Salinas as well as in commercial fields that have demonstrated the fertilizer value of high nitrate irrigation water during this rapid phase of crop development.

In practice, it can be challenging for growers to determine how much fertilizer credit to take for the irrigation water that they apply to their crops. Growers may irrigate crops with water blended from multiple wells. Nitrate concentration of wells can change during the season as aquifer levels rise and fall. Finally, large vegetable operations need to

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manage hundreds of vegetable fields during the season. Growers would need to invest significant amounts of labor to track the water applied to each of these fields.

Crop N removed (R): Estimating the amount of N removed in a harvested crop (R) may be useful for estimating nitrate loading to a ground water basin, but this exercise does not help growers better manage fertilizer N. The portion of the crop harvested is determined by market standards and demands, and therefore is out of the grower's control.

If "R" becomes a reporting requirement in Ag Order 4.0 then procedures for estimating "R" should be designed to be simple and inexpensive for growers to implement. A simple spreadsheet calculation tool might be used to estimate "R" from marketable yield and average values of the N content of the harvested commodity. The N content of the harvested parts of many vegetable and berry crops is either published or has been previously determined by UCCE advisors and specialists. Additional studies may be needed for some crops where the N content of the harvested product is uncertain.

Because marketable yield data for most growers is considered proprietary information, a reporting method would be needed so that yield information could not be back calculated from the submitted "R" data.

It should be mentioned that A:R ratios do not reflect the agronomic realities of producing a crop. Crops need nitrogen for the entire biomass (harvested and unharvested portions). Nitrogen use efficiency (NUE) which compares the applied N to total crop N uptake would be a more useful tool to help growers better manage their crops and would still provide information about potential loading of nitrate to the underlying aquifers.

Organic Farming Operations

The amount of nitrate leaching that occurs in organic vegetable production is unclear. A number of factors should be considered

- Total quantity of N applied relative to crop removal (A/R)
- Nitrogen (N) content of the material (higher analysis materials mineralize a greater portion of the total quantity of N that they contain)
- Fate of the N not mineralized during the cropping season

In the last three years we evaluated the nitrogen dynamics in organic cool season vegetable production systems on the Central Coast. As part of the evaluation we conducted N mineralization studies of common organic fertilizers both in the field and in the laboratory at UC Davis. The results indicated that 4-4-2 fertilizer (a blend of chicken manure and bone and feather meals) released about 40% to 60% of the N in the fertilizer over 60 days while 12-0-0 (feather meal), which has a higher percentage of nitrogen, mineralized about 60% to 85% of the N during the same period (Table 1). Organic

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amendments such as compost which can may have a low N concentration often mineralize slowly throughout the season.

Table 1. Percent of total N in organic fertilizer mineralized

Material	Laboratory[1] incubation	Field [2] Evaluation
4-4-2	38	60
12-0-0	59	85

1 – incubated at 68 °F for 56 days; 2 – polyethylene pouches buried 3 inches deep in the soil over lettuce crop cycle, 65 days.

The release pattern of the organic fertilizers and amendments follows a typical pattern of rapid release followed by a slow steady release (Figure 1). The fast release is attributable to the mineralization of labile forms of N and the slow release is attributable to the more recalcitrant forms of N.

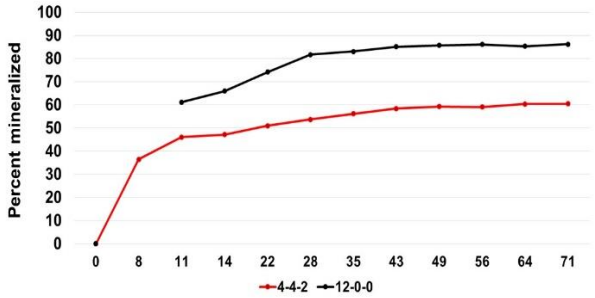

Figure 1. Pattern of release of N from organic fertilizers

Because N mineralization rates characteristically vary for different organic fertilizers and amendments, and are influenced by temperature and soil moisture content, it can be difficult to estimate the amount of mineral N that was available to organically produced vegetable crops. The fate of unmineralized N in the organic fertilizers and amendments is not well understood, but it is assumed that it is acting like soil organic matter, building up the organic N fraction of the soil.

The bottom line is that assessing A:R ratios for organic vegetable production systems is problematic. Net mineralization of N should be considered rather than the total amount of N applied in the fertilizer. Net mineralization will depend on the material, soil conditions, and weather. No factor for calculating the net mineralization can be provided here. It is suggested that a thorough evaluation of the literature and discussion with researchers will be needed to determine the calculation factors.

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An additional implication is that organic growers may have a greater challenge to efficiently manage N in their vegetable crops compared to conventional growers. Many short season vegetable crops have high N uptake rates (4 to 7 lbs of N/acre/day) during the rapid phase of growth, and the ability to satisfy this N demand not only depends on the amount of organic fertilizer and amendments applied to the crop, but also on the mineralization characteristics of the applied material.

Numeric limits

Determining fair numeric limits for nitrogen loading may be problematic for many of the reasons outlined in the above paragraphs. Growers often have limited ability to determine the appropriate A_{fert} due to factors such as the initial conditions of the field, weather events, and difficulties with predicting N mineralization from previous crop residues, soil organic matter, and organic fertilizers and amendments. In addition, they need to factor in nitrate applied in the irrigation water into their calculations.

Also, more than 50 economically important types of vegetables are produced on the Central Coast, each with different challenges for managing fertilizer N. Baby spinach for example is irrigated with sprinklers, is shallow rooted, and has high rates of N uptake. Defects such as yellowing of the margins of the leaves due to N deficiency can render a spinach crop unmarketable. In contrast, deep rooted vegetables crops such as broccoli and Brussels sprouts can scavenge nitrate located deep in the soil profile in the later stages of development; but the plant residues that are incorporated into the soil after harvest can release significant amounts of nitrate that could potentially leach. The complexity of managing N for each of these commodities should be considered in developing numeric limits for nitrate loading.

Thank you for considering our comments.

Respectfully,

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